based on the highest measured valued over the 14-day period.

(d) Use good engineering judgment to test fuel line segments with short length or narrow inner diameter. For example, size the fuel reservoir appropriately for the tested fuel line and take steps to eliminate air bubbles from narrow-diameter fuel lines.

[73 FR 59298, Oct. 8, 2008, as amended at 74 FR 8427, Feb. 24, 2009; 75 FR 23027, Apr. 30, 2010]

§ 1060.520 How do I test fuel tanks for permeation emissions?

Measure permeation emissions by weighing a sealed fuel tank before and after a temperature-controlled soak.

(a) *Preconditioning durability testing.* Take the following steps before an emission test, in any order, if your emission control technology involves surface treatment or other post-processing treatments such as an epoxy coating:

(1) *Pressure cycling.* Perform a pressure test by sealing the tank and cycling it between +13.8 and −1.7 kPa (+2.0 and −0.5 psig) for 10,000 cycles at a rate of 60 seconds per cycle. The purpose of this test is to represent environmental wall stresses caused by pressure changes and other factors (such as vibration or thermal expansion). If your tank cannot be tested using the pressure cycles specified by this paragraph (a)(1), you may ask to use special test procedures under § 1060.505.

(2) *UV exposure.* Perform a sunlight-exposure test by exposing the tank to an ultraviolet light of at least 24 W/m^2 (0.40 W-hr/m^2/min) on the tank surface for at least 450 hours. Alternatively, the fuel tank may be exposed to direct natural sunlight for an equivalent period of time as long as you ensure that the tank is exposed to at least 450 daylight hours.

(3) *Slosh testing.* Perform a slosh test by filling the tank to 40–50 percent of its capacity with the fuel specified in paragraph (e) of this section and rocking it at a rate of 15 cycles per minute until you reach one million total cycles. Use an angle deviation of +15° to −15° from level.

(4) *Cap testing.* Perform durability cycles on fuel caps intended for use with handheld equipment by putting the fuel cap on and taking it off 300 times. Tighten the fuel cap each time in a way that represents the typical in-use experience.

(b) *Preconditioning fuel soak.* Take the following steps before an emission test:

(1) Fill the tank with the fuel specified in paragraph (e) of this section, seal it, and allow it to soak at 28 ±5 °C for at least 20 weeks. Alternatively, the tank may be soaked for at least 10 weeks at 43±5 °C. You may count the time of the preconditioning steps in paragraph (a) of this section as part of the preconditioning fuel soak as long as the ambient temperature remains within the specified temperature range and the fuel tank is at least 40 percent full; you may add or replace fuel as needed to conduct the specified durability procedures.

(2) Empty the fuel tank and immediately refill it with the specified test fuel to its nominal capacity. Be careful not to spill any fuel.

(3) [Reserved]

(4) Allow the tank and its contents to equilibrate to the temperatures specified in paragraph (d)(7) of this section. Seal the fuel tank as described in paragraph (b)(5) of this section once the fuel temperatures are stabilized at the test temperature. You must seal the tank no more than eight hours after refueling. Until the fuel tank is sealed, take steps to minimize the vapor losses from the fuel tank, such as keeping the fuel cap loose on the fuel inlet or routing vapors through a vent hose.

(5) Seal the fuel tank as follows:

(i) If fuel tanks are designed for use with a filler neck such that the fuel cap is not directly mounted on the fuel tank, you may seal the fuel inlet with a nonpermeable covering.

(ii) If fuel tanks are designed with fuel caps directly mounted on the fuel tank, take one of the following approaches:

(A) Use a production fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that you expect to be used with fuel tanks from the emission family. It would generally be appropriate to consider an HDPE fuel cap with a nitrile rubber seal to be worst-case.

(B) You may seal the fuel inlet with a nonpermeable covering if you separately account for permeation emissions from the fuel cap. This may involve a separate measurement of permeation emissions from a worst-case fuel cap as described in §1060.521. This may also involve specifying a worst-case Family Emission Limit based on separately certified fuel caps as described in §1060.103(e).

(C) If you use or specify a fuel gasket made of low-permeability material, you may seal the fuel inlet with a nonpermeable covering and calculate an emission rate for the complete fuel tank using a default value of 30 g/m^2/day for the fuel cap (or 50 g/m^2/day for testing at 40 °C). Use the smallest inside cross-sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

(iii) Openings that are not normally sealed on the fuel tank (such as hose-connection fittings and vents in fuel caps) may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(iv) Openings for petcocks that are designed for draining fuel may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(v) Openings for grommets may be sealed using nonpermeable fittings such as metal or fluoropolymer plugs.

(vi) Rather than sealing a fuel tank with nonpermeable fittings, you may produce a fuel tank for testing without machining or stamping those holes.

(c) *Reference tank.* A reference tank is required to correct for buoyancy effects that may occur during testing. Prepare the reference tank as follows:

(1) Obtain a second tank that is identical to the test tank. You may not use a tank that has previously contained fuel or any other contents that might affect its mass stability.

(2) Fill the reference tank with enough glass beads (or other inert material) so the mass of the reference tank is approximately the same as the test tank when filled with fuel. Considering the performance characteristics of your balance, use good engineering judgment to determine how similar the mass of the reference tank needs to be to the mass of the test tank.

(3) Ensure that the inert material is dry.

(4) Seal the tank.

(d) *Permeation test run.* To run the test, take the following steps after preconditioning:

(1) Determine the fuel tank's internal surface area in square-meters, accurate to at least three significant figures. You may use less accurate estimates of the surface area if you make sure not to overestimate the surface area.

(2) Weigh the sealed test tank and record the weight. Place the reference tank on the balance and tare it so it reads zero. Place the sealed test tank on the balance and record the difference between the test tank and the reference tank. This value is M_o. Take this measurement directly after sealing the test tank as specified in paragraphs (b)(4) and (5) of this section.

(3) Carefully place the tank within a temperature-controlled room or enclosure. Do not spill or add any fuel.

(4) Close the room or enclosure as needed to control temperatures and record the time. However, you may need to take steps to prevent an accumulation of hydrocarbon vapors in the room or enclosure that might affect the degree to which fuel permeates through the fuel tank. This might simply involve passive ventilation to allow fresh air exchanges.

(5) Ensure that the measured temperature in the room or enclosure stays within the temperatures specified in paragraph (d)(6) of this section.

(6) Leave the tank in the room or enclosure for the duration of the test run.

(7) Hold the temperature of the room or enclosure at 28 ±2 °C; measure and record the temperature at least daily. You may alternatively hold the temperature of the room or enclosure at 40 ±2 °C to demonstrate compliance with the alternative standards specified in §1060.103(b).

(8) Measure weight loss daily by retaring the balance using the reference tank and weighing the sealed test tank. Calculate the cumulative weight loss in grams for each measurement. Calculate the coefficient of determination, r^2, based on a linear plot of cumulative weight loss vs. test days. Use the equation in 40 CFR 1065.602(k),

with cumulative weight loss represented by y_i and cumulative time represented by $y_{ref.}$ The daily measurements must be at approximately the same time each day. You may omit up to two daily measurements in any seven-day period. Test for ten full days, then determine when to stop testing as follows:

(i) You may stop testing after the measurement on the tenth day if r^2 is at or above 0.95 or if the measured value is less than 50 percent of the applicable standard. (Note that if a Family Emission Limit applies for the family, it is considered to be the applicable standard for that family.) This means that if you stop testing with an r^2 below 0.95, you may not use the data to show compliance with a Family Emission Limit less than twice the measured value.

(ii) If after ten days of testing your r^2 value is below 0.95 and your measured value is more than 50 percent of the applicable standard, continue testing for a total of 20 days or until r^2 is at or above 0.95. If r^2 is not at or above 0.95 within 20 days of testing, discontinue the test and precondition the fuel tank further until it has stabilized emission levels, then repeat the testing.

(9) Record the difference in mass between the reference tank and the test tank for each measurement. This value is M_i, where *i* is a counter representing the number of days elapsed. Subtract M_i from M_o and divide the difference by the internal surface area of the fuel tank. Divide this g/m^2 value by the number of test days (using at least two decimal places) to calculate the emission rate in $g/m^2/day$. Example: If a tank with an internal surface area of 0.720 m^2 weighed 1.31 grams less than the reference tank at the beginning of the test and weighed 9.86 grams less than the reference tank after soaking for 10.03 days, the emission rate would be—

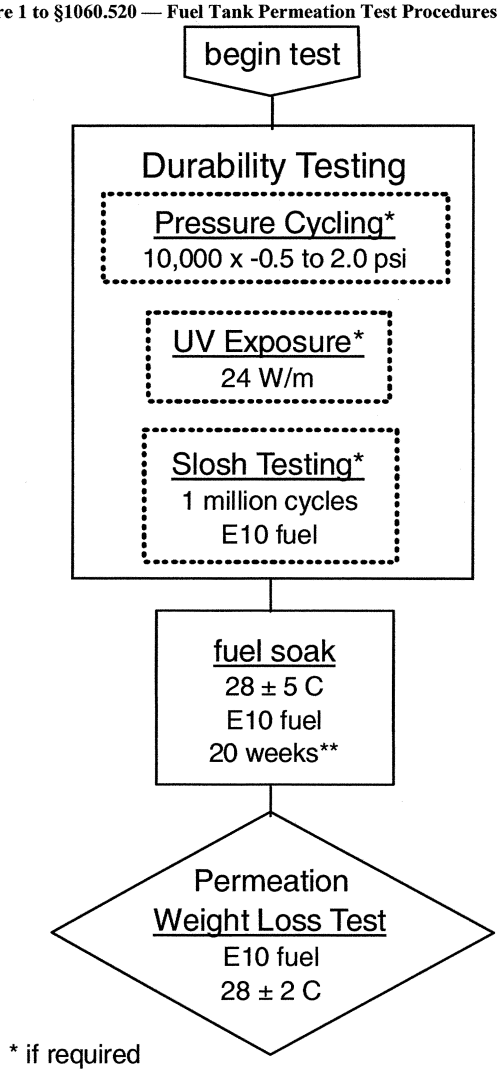
$((-1.31\ g) - (-9.82\ g))/0.720\ m^2/10.03\ days = 1.1784\ g/m^2/day$

(10) Determine your final emission result based on the cumulative weight loss measured on the final day of testing. Round this result to the same number of decimal places as the emission standard.

(e) *Fuel specifications.* Use gasoline blended with ethanol such that the blended fuel has 10.0 ±1.0 percent ethanol by volume as specified in §1060.501. As an alternative, you may use Fuel CE10, as described in §1060.515(a)(1).

(f) *Flow chart.* The following figure presents a flow chart for the permeation testing described in this section:

Figure 1 to §1060.520 — Fuel Tank Permeation Test Procedures



* if required

*** The length of "soak" during durability testing may be included in the fuel soak period provided that fuel remains in the tank. Soak periods can be shortened to 10 weeks if performed at 43* ± 5 C

[73 FR 59298, Oct. 8, 2008, as amended at 75 FR 23027, Apr. 30, 2010]

§ 1060.521 How do I test fuel caps for permeation emissions?

If you measure a fuel tank's permeation emissions with a nonpermeable covering in place of the fuel cap under § 1060.520(b)(5)(ii)(B), you must separately measure permeation emissions from a fuel cap. You may show that your fuel tank and fuel cap meet emission standards by certifying them separately or by combining the separate measurements into a single emission rate based on the relative surface areas of the fuel tank and fuel cap. However, you may not combine these emission measurements if you test the fuel cap at a nominal temperature of 28 °C and you test the fuel tank at 40 °C. Measure the fuel cap's permeation emissions as follows:

(a) Select a fuel cap expected to have permeation emissions at least as high as the highest-emitting fuel cap that you expect to be used with fuel tanks from the emission family. Include a gasket that represents production models. If the fuel cap includes vent paths, seal these vents as follows:

(1) If the vent path is through grooves in the gasket, you may use another gasket with no vent grooves if it is otherwise the same as a production gasket.

(2) If the vent path is through the cap, seal any vents for testing.

(b) Attach the fuel cap to a fuel tank with a capacity of at least one liter made of metal or some other impermeable material.

(c) Use the procedures specified in § 1060.520 to measure permeation emissions. Calculate emission rates using the smallest inside cross sectional area of the opening on which the cap is mounted as the fuel cap's surface area.

§ 1060.525 How do I test fuel systems for diurnal emissions?

Use the procedures of this section to determine whether your fuel tanks meet diurnal emission standards as specified in § 1060.105.

(a) Except as specified in paragraph (c) of this section, use the following procedure to measure diurnal emissions:

(1) Diurnal measurements are based on a representative temperature cycle. For marine fuel tanks, the temperature cycle specifies fuel temperatures rather than ambient temperatures. The applicable temperature cycle is indicated in the following table:

TABLE 1 TO § 1060.525—DIURNAL TEMPERATURE PROFILES FOR FUEL TANKS

Time (hours)	Ambient Temperature Profile for Land-based Fuel Tanks (°C)	General Fuel Temperature Profile for Installed Marine Fuel Tanks (°C)	Fuel Temperature Profile for Marine Fuel Tanks Installed in Nontrailerable Boats (°C)
0	22.2	25.6	27.6
1	22.5	25.7	27.6
2	24.2	26.5	27.9
3	26.8	27.9	28.5
4	29.6	29.2	29.0
5	31.9	30.4	29.5
6	33.9	31.4	29.9
7	35.1	32.0	30.1
8	35.4	32.2	30.2
9	35.6	32.2	30.2
10	35.3	32.1	30.2
11	34.5	31.7	30.0
12	33.2	31.0	29.7
13	31.4	30.2	29.4
14	29.7	29.3	29.1
15	28.2	28.6	28.8
16	27.2	28.0	28.5
17	26.1	27.5	28.3
18	25.1	27.0	28.1
19	24.3	26.6	28.0
20	23.7	26.3	27.9
21	23.3	26.1	27.8
22	22.9	25.9	27.7
23	22.6	25.7	27.6